Forages and Global Warming
Eugene S. Takle

The earth is getting warmer

Evidence continues to mount that the earth is getting warmer at an unprecedented rate. Plants across Europe and around the Mediterranean Sea are flowering about a week earlier than 50 years ago. Adelie penguins in Antarctica are abandoning nesting areas used for the past 650 years because there is now too much open water. Mountain glaciers on all continents are observed to be receding in response to global warming. In Bhutan in the Himalayan Mountains, melting glaciers are retreating up the mountains at a rate of 30-40 meters per year in response to accelerated warming. Forty-four lakes in Nepal and Bhutan are at risk to bursting natural dams within the next 5-10 years due to enhanced glacier melt water. Alaskan glacier thinning in the 1990s was almost 4 times the rate of the previous 40 years. Over the last 50 years, the number of frost-free days has increased by 20-25 days in California and the Pacific Northwest and 8-9 days in the Great Plains.

Temperatures for the Northern Hemisphere over the last 1000 years, as derived from tree rings, lake sediments, and other proxy data, show a gradual decrease from 1000 to 1900 with an abrupt rise since 1900, particularly since 1970. The balance of evidence suggests humans have played a large role in the recent warming. Moreover, we are creating conditions that will almost certainly lead to substantial warming over the next 100 years.

Burning of fossil fuels increases atmospheric CO_2

Human activities of the industrial age such as burning fossil fuels, releasing chlorofluorocarbons, and deforestation have raised levels of greenhouse gases, mainly carbon dioxide (CO_2), far above natural levels. Nature takes hundreds of years to remove these excessive amounts of greenhouse gases. The current rate of increase of greenhouse gases is unprecedented. The atmosphere now contains more CO_2 than at any time in the last 420,000 years and possibly the last 20 million years. CO_2 has fluctuated from about 180 parts per million (ppm) to about 300 ppm until the beginning of the industrial revolution when human-induced CO_2 emissions began to rise. It now stands at 370 ppm. Current and projected future emission rates allow us to calculate with confidence that CO_2 concentrations will be at least 500 ppm by 2050 even with severe limits on emissions and may reach 600 ppm. If we allow for rapid economic growth based on continued use of fossil fuels, CO_2 will reach about 950 ppm by 2100.

Estimating future climate

Scientists use complex computer models of the global climate system to assess changes in precipitation, temperature, and other climate variables that are expected to accompany these increases in greenhouse gases. Model results summarized by the Intergovernmental Panel on Climate Change (IPCC) estimate a global average temperature rise of 2.5-10.4^{o}F over the next 100 years due to expected increases in greenhouse gases. Recent scientific reports conclude there is a 40% chance that warming by 2100 will exceed the IPCC estimate and only a 5% chance that it will be below this range. There is no scientific evidence to suggest that global average temperatures will remain constant or decline in the next 100 years. The issue then is not whether warming will occur, but rather what other changes are likely to accompany this warming, and what do we do about it.

The dilemma of increasing CO_2 has a near term (now to 2030) and a long term (2030-2100) component. We can say with high confidence that the earth is committed to a warming of 0.7-2.2^{o}F over the next 30 years, ***regardless of what we do to control emissions***. We no longer have any control over global warming during this period. Our economic and political strategy for the near term must be one of adaptation to anticipated changes. In the long term, we do have some control, but this will be for generations yet unborn who inherit a planet that will be much warmer than today.

Adapting to climate change

Over the next 30 years, adapting to climate change– our only option, since warming is assured – begs the question of how much the climate will change in various regions of the US. A rise in daily maximum temperature of 3 degrees Fahrenheit in Iowa, for instance, would triple the probability of summertime heatwaves. We know temperatures will rise but we don't know by exactly how much. Some regions of the globe, of course, will have temperature increases more than the one degree Fahrenheit global average. Many regions will be affected both ecologically and economically by such increases.

We can say with confidence that across the US winter temperatures will rise more than summer temperatures and more in the north and west than in the south and east. This warming already is in progress, with the number of frost-free days having increased by 20-25 days in California and the Pacific Northwest and 8-9 days in the Great Plains over the last 50 years. These changes can be expected to influence energy demands for heating and cooling and water management strategies that rely on snowpack as a natural storage reservoir.

Nighttime temperatures are likely to rise more than daytime temperatures due to more cloudiness and somewhat higher humidity. These future changes also will continue observed trends over the last few decades.

We can expect a longer growing seasons across the US, extended slightly more in spring than fall in regions now having snow cover. This will bring increases in growing degree days and earlier planting and weed germination compared to current conditions. Slightly higher daytime temperatures will increase the likelihood of long runs of successive days with temperatures above critical thresholds (so-called “heat waves”), such as 90 degrees Fahrenheit for corn.

Wind speeds (and therefore wind power resources) will diminish modestly even though isolated storms may have higher intensity. More summertime precipitation in the US Midwest likely will come in intense storms, leading to more run-off and higher episodic stream flow and more variability in stream flow. Somewhat higher total precipitation, more of which falls on unfrozen soil, will lead to generally higher soil moisture, particularly during the agriculturally important July-August period.

Rivers, streams, and lakes will likely be frozen for shorter periods during the winter and will have higher temperatures in summer, with lowered dissolved oxygen content that may negatively impact fish populations. Summer fluctuations in stream flow likely will be larger than at present.

These changes have both good and bad consequences, and we need to look for ways to take advantages where we can and protect against adversities that seem likely. Wider use of forages in the landscape can increase resiliency of soil resources in a changing climate,

Forages contribute to sustainability in a changing climate

Our regional climate model results suggest that over the next 40 years precipitation will increase by 15-20%, with more precipitation coming in heavier rainfall events. Rain falling on saturated soils mostly becomes runoff, so more intense rain events will lead to more runoff. Our simulations indicate that a 16% increase in precipitation leads to a 64% increase in streamflow in the Upper Mississippi River Basin. Annual cropping of the landscape will leave the soil highly vulnerable to increased erosion. And annual crops requiring nitrogen fertilizer will contribute more than present to nitrogen loading in major rivers. Judicious use of perennial forage crops will contribute substantially to mitigating negative impacts of increased precipitation.

Intense tillage of Iowa soils has reduced soil organic material by about 50% from amounts contained in virgin prairies. Management practices that reduce tillage and promote below-ground carbon accumulations have multiple benefits: additional loss of soil carbon is suppressed, accumulation of soil carbon reduces atmospheric CO_2 levels, water-holding capacity of soils is increased, and soil erosion is reduced. Emerging markets providing credits for sequestering carbon in soils may provide landowners opportunities for increased income while at the same time protecting one of Iowa’s most valuable resources.

Biographical Information

Eugene S. Takle is Professor of Agricultural Meteorology in the Department of Agronomy and Professor of Atmospheric Science in the Department of Geological and Atmospheric Sciences at Iowa State University. His research includes simulating regional and microscale climate by use of computer models. He and his colleagues manage the international Project to Intercompare Regional Climate Simulations (PIRCS), which brings together more than 15 regional climate modeling groups from 12 countries to perform experiments for improving climate models. He also leads a group of scientists studying turbulent flow through agricultural shelterbelts. Results of these studies are being evaluated and used for designing shelterbelts for creating barriers and microclimates for increased crop production, reduced soil erosion, increased snow deposition, reduced particulate and pollen transport, and increased biodiversity in the landscape.

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Speaker Information

Equipment needed:	Video projection unit (I will bring my Mac G4 laptop)
Room reservation:	I will NOT need a room.
Noon luncheon:	I WILL attend the Nov 26 noon luncheon